PX 525

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

SECURITIES AND EXCHANGE
COMMISSION,

Plaintiff

v

RIPPLE LABS, INC., BRADLEY
GARLINGHOUSE, AND
CHRISTIAN A. LARSEN,

Defendants

20 Civ. 10832

EXPERT REBUTTAL REPORT OF

███████ **Ph.D.**

████████████████████

NOVEMBER 12, 2021

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I.   Assignment

1. I have been retained by the Securities and Exchange Commission ("SEC") to provide expert opinions in the matter captioned above. I previously submitted an expert report on October 4, 2021 (" ███ Report"), in which I performed an empirical analysis of XRP's price movements and assessed whether news of actions by Ripple Labs, Inc. impacted XRP prices. I additionally assessed the extent to which XRP price movements were driven by price movement in Bitcoin and other digital tokens. My qualifications, publications, and prior testimonies are described in that report.

2. Allen Ferrell, Ph.D. submitted an expert report on behalf of Ripple Labs, Inc. on October 4, 2021 (the "Ferrell Report"). I have been asked to review and respond to certain opinions expressed in the Ferrell Report regarding variation in long-run XRP price returns and factors that could and could not explain that variation as identified by Dr. Ferrell.

3. My opinions are based on my knowledge and expertise gained during my professional career and my academic training and research. In forming my opinions in this matter, I have considered certain additional documents provided to me. Those documents and materials I relied upon for the ███ Report were identified in Appendix B to that report. Any additional documents or materials relied upon for this report are listed in Appendix A attached to this report, which include documents cited by the Ferrell Report. In addition, I have prepared work papers that are available upon request.

4. The opinions stated in this report are based on the evidence that has been provided to me to date. My work in this matter is ongoing, and I reserve the right to modify or supplement my conclusions as additional information is made available to me, or as I perform further analysis. ███████████ ███ an hourly rate of $600 for my time in this matter. Staff at The Brattle Group have assisted me by performing work at my direction. My opinions are my own, and neither The Brattle Group's nor my compensation are dependent on my opinions or the outcome of this matter.

II.   Summary of Opinions

5. The Ferrell Report employs various statistical tests in an attempt to show that XRP returns can be explained by broader movements in the digital token market, and from the results of these statistical tests Dr. Ferrell concludes that XRP price returns (at least "long run returns") "are associated with factors outside Ripple's control."[1] He further concludes that those returns "are unrelated to factors

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[1]   Ferrell Report, ¶ 13.

over which Ripple may have control, including the various distributions of XRP."[2] I have reviewed this portion of the Ferrell Report and have reached the following opinions:

- **The Ferrell Report's tests are not well defined conceptually in that they do not test any meaningful hypotheses relevant to the matter at hand.**

  - Dr. Ferrell's ultimate statistical finding that XRP price returns are "associated with factors outside of Ripple's control" is not disputed; *all* security price returns are associated with factors outside the control of the issuing party.[3] My first report in this matter presents a discussion of such relationships.

  - If Dr. Ferrell means to suggest that because XRP price returns are associated with factors outside of Ripple's control, they therefore cannot be associated with any factors inside Ripple's control, that is false as a matter of logic.

- **The Ferrell Report's analysis of whether Ripple's XRP distributions impacted XRP price returns does not address whether any other actions by Ripple might have impacted XRP price returns. Dr. Ferrell makes no attempt to evaluate any other news or actions by Ripple.**

  - Dr. Ferrell's statistical finding that XRP price returns are "unrelated" to XRP distributions, even if true, does not speak to whether XRP price returns are "related" to any other factors inside Ripple's control.

  - Although Dr. Ferrell frames his conclusion as applying to Ripple-controlled factors "***including*** the various distributions of XRP" (emphasis added), his analysis is *limited* to XRP distributions—and Dr. Ferrell makes no attempt to evaluate the impact of any other Ripple-controlled factors.

  - The Ferrell report does not include an "event study analysis," which is the commonly accepted method to determine if news significantly impacts price returns.

- **The Ferrell Report's finding that average (excess) XRP price returns are not statistically significant is unsurprising and is in fact consistent with modern asset pricing theory.**

  - Applying the Ferrell Report methodology to the well-known stocks comprising the Dow Jones Industrial Average indicates, in almost all cases, that the average (excess) returns of those stocks are also not statistically significant. It would be absurd to suggest that *therefore* the prices of the stocks in the Dow Jones Industrial Average are totally unaffected by the actions of their issuers (they plainly are), or that investors in those stocks do not rely on the actions of those issuers to make a profit (they plainly do).

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[2]   Ferrell Report, ¶ 13.

[3]   I am not opining in this report on whether or not Ripple's offers and sales of XRP were offers and sales of securities. Rather, I apply Dr. Ferrell's test to securities in Section V to illustrate that the test cannot appropriately be used to draw the conclusion that Dr. Ferrell does here, i.e., that Ripple's actions did not affect the price of XRP.

- – In fact, almost all stocks comprising the Dow Jones Industrial Average would fail Dr. Ferrell's statistical analyses, which indicates that Dr. Ferrell's analytical framework is not suited for the matter at hand.

- **The Ferrell Report's finding of a high adjusted R^2 should not be interpreted as indicating that there is no scope for other factors not accounted for by Dr. Ferrell—including factors under the control of Ripple—to also significantly impact XRP price returns.**
  - – The adjusted R^2 in excess of 90% found in some of Dr. Ferrell's models is attributable to three unusual monthly returns. This same model explains only a little over 30% of the variation of the other 67 monthly returns of XRP.
  - – The magnitude of the monthly returns that remain unexplained by Dr. Ferrell's models is economically large, often in excess of 100%.

- **The statistical analyses employed by Dr. Ferrell are not robust in many respects.**
  - – Dr. Ferrell does not appear to have examined his pricing data for "outliers," and his procedure of appending one pricing data source onto another leads to spurious and nonsensical estimates of price returns.
  - – Dr. Ferrell does not appear to have considered that certain parameters of his models can and do change over time.
  - – Dr. Ferrell's methodology appears numerically unstable. His principal components are sensitive to outliers in his underlying data, outliers which in some cases appear to be spurious. This becomes apparent when I replicate his analysis starting on different days. As a result of these sensitivities, measures of model fit can range from 14% to 58%, and the explanatory power of the principal components can range from 40% to 100%, depending on the day on which the analysis begins.

- **Accepting all of Dr. Ferrell's results as correct would not answer the question of whether news and actions of Ripple impacts XRP price returns or not.**
  - – As I showed in my first report, XRP prices are affected by broad "cryptocurrency" factors, but they are also affected by certain news and actions of Ripple. There is no contradiction between those positions. Since Dr. Ferrell does not test whether XRP prices react to news and actions of Ripple beyond the XRP distributions he studies, his report cannot speak to these issues.
  - – Dr. Ferrell does not cite to any scientific authority that endorses his approach that finding (i) statistically insignificant regression intercepts with (ii) some statistically significant market factors establishes that the asset's price is therefore "unrelated to factors" over which the issuer "may have control."

III. Review of Dr. Ferrell's Analysis

6. In the section of the Ferrell Report titled "Variation in Long-Run XRP Price Return is Explained by Factors Outside of Ripple's Control,"[4] Dr. Ferrell uses a framework known as the "factor model" to argue that factors outside of Ripple's control affect XRP long-run price returns. In this section I briefly summarize aspects of his methodology.

7. Dr. Ferrell explains that "factor models are used to determine the factors that explain the common component of the variation in asset price returns."[5] In practice, different models utilize different types and numbers of factors. Commonly used factors in finance include market indices, such as indices for stocks, commodities, and currencies. Dr. Ferrell states that many factor models include market indices as factors, which Dr. Ferrell claims are unavailable for the digital token market.[6] Dr. Ferrell therefore chooses to employ a statistical technique known as "principal components analysis" ("PCA") to construct factors from the returns of other, non-XRP digital tokens.

8. Dr. Ferrell examines 28-day XRP returns over two different periods: August 6, 2013 – December 15, 2020 ("Period 1") and August 11, 2015 – December 20, 2020 ("Period 2").[7] The principal components ("PCs") in Period 1 are constructed from nine digital tokens that were traded during that period (though not all were traded continuously throughout that period), while the PCs in Period 2 are constructed from 91 digital tokens (again, not all of which were traded continuously through the period in question).[8]

9. Across different regression specifications, Dr. Ferrell is primarily interested in the following statistical results. First, he tests whether the constant in his regressions (also known as "alpha") is significantly different from zero or not.[9] Second, he notes whether the coefficient on any of the PCs in his regressions (also known as "beta") is significantly different from zero or not.[10]

10. In all of his models, Dr. Ferrell finds that alpha is statistically insignificant (meaning, Dr. Ferrell cannot reject the hypothesis that it is zero at the 5% significance level) and at least one "beta" is statistically

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[4]   Ferrell Report, Section III.C.
[5]   Ferrell Report, ¶ 91.
[6]   Ferrell Report, ¶ 93.
[7]   Ferrell Report, ¶¶ 95 and 97.
[8]   Ferrell Report, ¶ 93.
[9]   Ferrell Report, ¶ 96.
[10] Ferrell Report, ¶ 98.

significant (meaning, for at least one factor in his model Dr. Ferrell can reject the hypothesis that its coefficient is zero at the 5% significance level).[11]

11.   By failing to find a statistically significant alpha, Dr. Ferrell concludes that there are "no remaining average 'excess' XRP price returns that are unexplained by the model."[12] Dr. Ferrell interprets finding at least one statistically significant beta in his models as a demonstration of "the importance of the underlying cryptocurrencies in explaining variation in XRP price returns."[13]

12.   In those models which add certain XRP distributions, Dr. Ferrell finds that the regression coefficients on those distributions are not significant at the 5% level.[14] From this, Dr. Ferrell concludes that Ripple's XRP distributions have no effect on XRP's long-run price returns.[15]

13.   From the basic results that (i) "alpha" is not significant, (ii) at least one "beta" is significant, and (iii) other conventional pricing factors are insignificant, Dr. Ferrell concludes that (i) "Variation in long-run XRP price return can be explained by exogenous cryptocurrency market factors that are outside Ripple's control," that (ii) "Non-cryptocurrency assets (e.g., equities) are not correlated with XRP price return, controlling for cryptocurrency market factors," and that (iii) "On average, XRP price returns are not statistically different than zero, controlling for cryptocurrency market factors, over which Ripple has no control."[16] This apparently leads him to conclude that "none of those [XRP] returns is owing to the efforts of Ripple."[17]

14.   As I describe in the following sections, Dr. Ferrell's analysis simply cannot and does not address the question of whether XRP prices react to news about Ripple's actions. His conclusion that XRP returns "owe nothing" to the actions of Ripple is therefore unsupported and unreliable. In addition, his analysis is poorly specified in many ways and his results are not robust.

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[11]   In what follows I shall adopt the conventional shorthand that some parameter may be "statistically significant" or "statistically insignificant" to describe cases where the hypothesis can or cannot be rejected at the 5% significance level, respectively.

[12]   Ferrell Report, ¶ 102.

[13]   Ferrell Report, ¶ 99.

[14]   Ferrell Report, ¶¶ 115-117 and Exhibits 11A, 11B, 12A, and 12B.

[15]   Ferrell Report, ¶ 118.

[16]   Ferrell Report, ¶ 90.

[17]   Ferrell Report, ¶ 118.

IV. Dr. Ferrell's Analysis Cannot and Does Not Answer the Question of Whether XRP Prices React to News about Ripple's Actions

15. In Dr. Ferrell's summary of conclusions, he writes that "XRP price returns are unrelated to factors over which Ripple may have control, including the various distributions of XRP extensively invoked in the SEC's complaint."[18] This assertion is unsupported by Dr. Ferrell's analysis. Even accepting all of his results as correct, Dr. Ferrell's analysis would only serve to establish that (i) there is a relationship between XRP returns and those of other digital tokens (which is not disputed and which I established in the ███ Report), (ii) there is no additional relationship between XRP returns and a select set of other pricing factors (which is not relevant),[19] and (iii) there is no additional relationship between monthly XRP returns and the value of monthly distributions (which does not speak to Ripple's other efforts to build its network of customers and the broader XRP ecosystem). Since the analysis does not test whether XRP returns are related to any other news or action of Ripple, it does not support any conclusions related thereto.

16. The ███ Report demonstrated that, contrary to Dr. Ferrell's claims, XRP's prices have reacted to efforts taken by Ripple to develop the XRP ecosystem. My analysis was based upon the well-accepted econometric framework referred to as an event study, which is a technique that has been widely used in the academic literature and in the context of securities financial litigation.[20]

17. Dr. Ferrell does not include an event study in his report. Instead, Dr. Ferrell simply finds that XRP's *monthly* price returns move with those of non-XRP cryptocurrencies, and not with Ripple Labs' distributions of XRP. From this monthly correlation he concludes that XRP's price returns are explained by factors outside of Ripple Labs' control, and "purchasers of XRP can have no reasonable expectation of profits from the efforts of Ripple."[21] This is a logical leap that simply cannot be supported by the analysis he performs, if for no other reason than he tests only one form of action or effort by Ripple, the distribution of XRP tokens.

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[18] Ferrell Report, ¶ 13.

[19] Whether or not XRP returns are correlated with the financial indices selected by Dr. Ferrell has no bearing on the separate issue of whether XRP prices react to news or actions by Ripple.

[20] *See*, e.g., A. Craig MacKinlay, "Event Studies in Economics and Finance," *Journal of Economic Literature* Vol. 35, 1997, pp. 13-39 at p. 13; John J. Binder, "The Event Study Methodology Since 1969," *Review of Quantitative Finance and Accounting* Vol. 11, 1998, pp. 111-137 at p. 111; and Frank Torchio, "Proper Event Study Analysis in Securities Litigation," *The Journal of Corporation Law*, Vol. 35, 2009, pp. 159-168, at p. 159.

[21] Ferrell Report, ¶ 15.

18. Moreover, as shown in Figure 1, Dr. Ferrell makes this unsupported statement in increasingly strong language as his report progresses. At the beginning of the report, in paragraph 13, he writes simply (and without dispute) that XRP returns are "associated" with price returns of non-XRP cryptocurrencies, but by paragraph 118 he states that "long-run price returns are owing to non-XRP cryptocurrency market factors; none of those returns is owing to the efforts of Ripple."

FIGURE 1: SELECTED FERRELL REPORT QUOTES (EMPHASIS ADDED)

Quotes from the Ferrell Report	Paragraph
"My economic analysis demonstrates that XRP's long-run price returns are associated with factors outside Ripple's control, namely, price returns of non-XRP cryptocurrencies."	¶ 13
"Ripple's XRP distributions do not have a statistically significant relation with long-run XRP price return after controlling for returns of other non-XRP cryptocurrencies outside of Ripple's control."	¶ 82
"[M]y empirical analyses show that the variation in long-run price return of XRP can be explained by exogenous, non-XRP, cryptocurrency price returns or, put differently, by factors outside Ripple's control."	¶ 100
"These findings demonstrate that factors outside of Ripple's control… explain movements in long-run XRP price return. In other words, XRP's long-run price returns are owing to non-XRP cryptocurrency market factors; **none of those returns is owing to the efforts of Ripple**."	¶ 118

V. Dr. Ferrell's Analysis Is Poorly Specified and Irrelevant from an Economic Perspective

19. In this section, I will show that Dr. Ferrell's statistical argument is unfit to support his conclusions, as his analysis sheds no light on whether XRP prices are affected by Ripple's actions. First, he asserts that XRP price returns can be *explained* by cryptocurrency market factors outside Ripple's control, yet fails to examine or even mention the economically significant returns every month that are unexplained by his models. Second, he seems to rest his conclusion on finding significant "betas" and insignificant "alphas" in his various factor models, but that is generally what is expected with any financial asset, hence it is not clear whether any relevant conclusions can be drawn from such results. Finally, much of the variation in XRP's returns that he purports to explain is due to unusually large returns.

A.   Dr. Ferrell's Analysis Implausibly Suggests That the Actions of Major Corporations Have No Effect on the Prices of Their Stocks

20. Upon finding a statistically insignificant alpha and some significant betas in his factor models for XRP returns, Dr. Ferrell concludes that "variation in long-run price return of XRP can be explained by exogenous, non-XRP, cryptocurrency price returns or, put differently, by factors outside Ripple's control" and ultimately asserts that those returns are unrelated to *any* actions of Ripple.[22] Yet these statistical results on alpha and beta seem perfectly consistent with asset pricing theory, not contrary to it.

21. The fallacy of Dr. Ferrell's analysis can be demonstrated by applying that analysis to well-known stocks in the U.S. stock market. Dr. Ferrell's logic implies that the prices of those stocks must be unrelated to the actions of their issuers, yet we know that is not true.

22. To illustrate, I apply Dr. Ferrell's methodology to the current constituents of the Dow Jones Industrial Average ("DJIA"), an index of large blue chip stocks. That is, I construct 28-day returns for each stock in the DJIA and subtract the same risk-free rate that Dr. Ferrell uses. Then, for each constituent stock in sequence, I conduct a PCA across all other constituent stocks and regress the reference stock returns on some of the principal components.[23]

23. For each DJIA component stock, I note whether alpha is significant and whether any of the principal components enters the regression significantly (whether any of the betas is significant). If we find similar results here to what Dr. Ferrell found for XRP, should we then conclude that the actions of the company did not matter to the stock price?

24. As presented in Figure 2, I find that for 26 of 27 stocks in the DJIA, alpha is not statistically different from zero, while in all cases, at least some principal component enters the regression significantly. In other words, almost every member of the DJIA behaves exactly like XRP under Dr. Ferrell's statistical framework. Such results seem perfectly consistent with asset pricing theory, yet Dr. Ferrell interprets them as evidence that XRP prices are not affected by Ripple Labs. I find this conclusion implausible.

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[22]   Ferrell Report, ¶ 100.

[23]   To determine the number of PCs to use, I consider the same BIC calculation Dr. Ferrell suggests but further add a requirement that the number of PCs considered must span at least 95% of the variance of the reference data set.

FIGURE 2: DR. FERRELL'S METHOD APPLIED TO DOW JONES INDUSTRIAL AVERAGE

Company Name	Betas Significant?	Alpha Insignificant?	Adjusted R^2
	[A]	[B]	[C]
JPMorgan Chase & Co	✓	✓	0.752
Goldman Sachs Group Inc	✓	✓	0.741
Travelers Companies Inc	✓	✓	0.593
Visa Inc	✓	✓	0.575
Johnson & Johnson	✓	✓	0.521
Boeing Co	✓	✓	0.518
American Express Co	✓	✓	0.494
Walt Disney Co	✓	✓	0.488
Coca-Cola Co	✓	✓	0.469
Home Depot Inc	✓	✓	0.465
Chevron Corp	✓	✓	0.462
3M Co	✓	✓	0.459
Microsoft Corp	✓	✓	0.455
IBM Corp	✓	✓	0.446
Cisco Systems Inc	✓	✓	0.417
Intel Corporation	✓	✓	0.380
Caterpillar Inc	✓	✓	0.365
Amgen Inc	✓	✓	0.357
Salesforce.com Inc	✓	✓	0.356
NIKE Inc	✓	✓	0.309
Verizon Communications Inc	✓	✓	0.302
Procter & Gamble Co	✓	✓	0.293
McDonald's Corp	✓	✓	0.266
Apple Inc	✓	✓	0.266
Merck & Co Inc	✓	✓	0.251
UnitedHealth Group Inc	✓		0.237
Walmart Inc	✓	✓	0.130

Notes:

The significance of Beta is determined by an F-test. The insignificance of Alpha is determined by a T-test.

[A]: Checkmark indicates significant at the 5% level.

[B]: Checkmark indicates not significant at the 5% level.

B.   Dr. Ferrell's Model Effectively Explains Just Three Monthly Returns in Six Years

25.   In this subsection, I show that the variation explained by Dr. Ferrell's PCA model is concentrated on three months with extreme returns, while the model explains relatively little of the variation on XRP's prices outside of those three months.

26.   From Exhibit 3 of Dr. Ferrell's report we see that the adjusted R^2 of his regression (a common measure of model fit) for Estimation Period 2 is 0.923; the unadjusted R^2, not reported in that Exhibit, is 0.935.[24] This means that these eleven principal components can explain over 93% of the variation in monthly XRP returns from August 11, 2015, through December 20, 2020. Under a superficial review, that might seem to leave very little room for other drivers, such as news or actions by Ripple (though that ignores the extent of the unexplained returns themselves). However, upon closer inspection, this impressive fit is achieved only because of three exceptionally high returns out of 70 observations. Figure 3 plots these 70 observations of monthly XRP returns that are the basis of that analysis and highlights the three dominant returns.

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[24]   Ferrell Report Backup Files.

FIGURE 3: MONTHLY XRP RETURNS IN ESTIMATION PERIOD 2
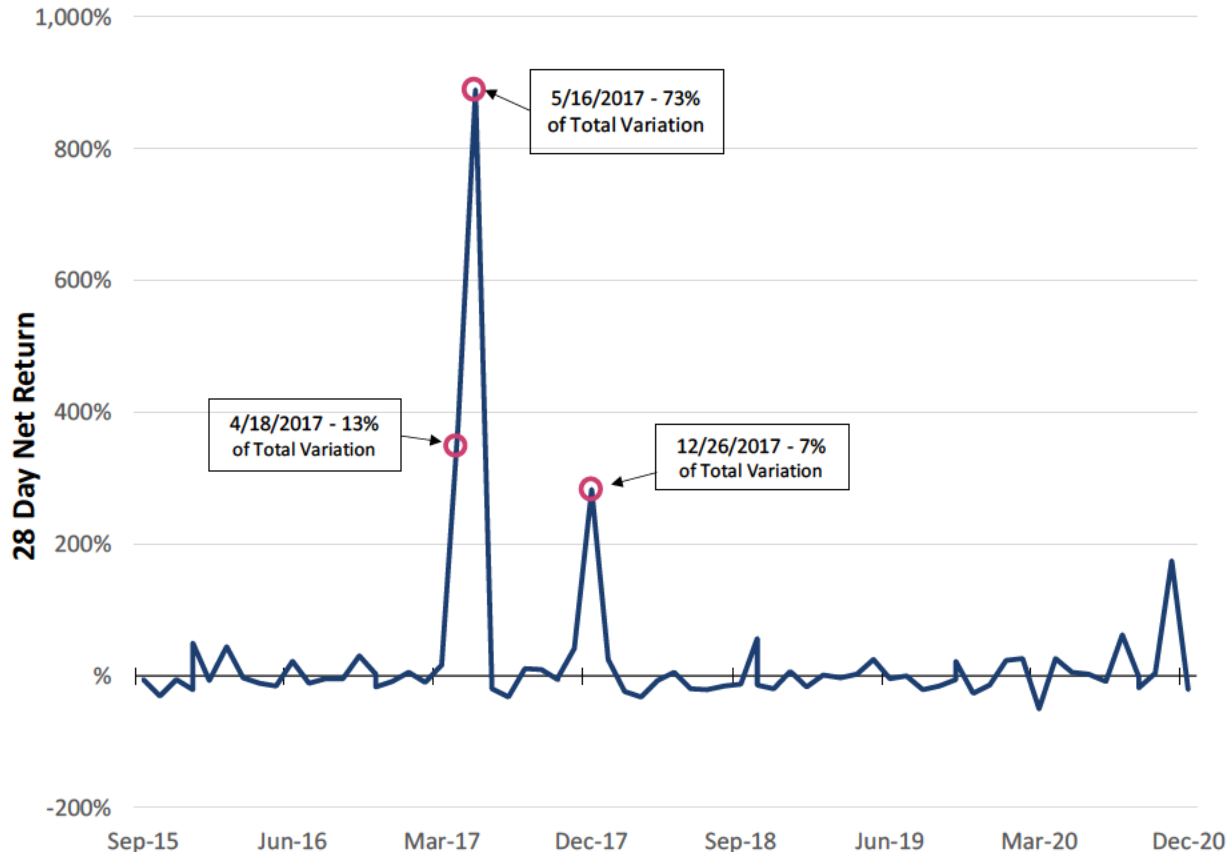
Source: Brattle Workpapers.

27. As depicted in Figure 3, XRP's net return for the 28-day period ending May 16, 2017 (the day Ripple Labs announced its intention to escrow 55 billion of its XRP tokens by the end of that year)[25] was 890.6%.[26] This single observation represents about 73% of the variation of the six years of data.[27] The previous return of the 28-day period ending April 18, 2017, is 381.0% and represents an additional 13% of the

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[25] "Ripple to Place 55 Billion XRP in Escrow to Ensure Certainty of Total XRP Supply," Brad Garlinghouse, *Ripple Insights,* May 16, 2017, accessed November 11, 2021, https://ripple.com/insights/ripple-to-place-55-billion-xrp-in-escrow-to-ensure-certainty-into-total-xrp-supply/.

[26] XRP's closing price on May 16, 2017 was $0.3250, while 28 days earlier on April 18, 2017, it was just $0.03281, leading to a 28-day return (gross of the risk-free rate) of 890.6%: $8.91 = 0.3250 / 0.03281 - 1$. The closing price just one day earlier on May 15, 2017, was $0.263. In other words, XRP's price increased $0.062 (23.5%) in just one day from May 15 to 16, 2017. See Ferrell Report Backup Files.

[27] Regressing on the single observation on May 16, 2017 results in an unadjusted R^2 of 0.73. *See* Brattle Workpapers.

total variation.[28] The return of December 26, 2017, is 282.7%, representing an additional 7.5% of the total variation.[29] Together, these three observations alone represent about 94% of the variation in XRP returns in Dr. Ferrell's data, as shown in Figure 4.

FIGURE 4: JUST THREE MONTHS EXPLAIN 94% OF THE VARIATION IN XRP RETURNS IN DR. FERRELL'S ESTIMATION PERIOD 2

		Coefficient [A]
Constant	[1]	0.02
05/16/2017	[2]	8.89***
04/18/2017	[3]	3.79***
12/26/2017	[4]	2.81***
Observations	[5]	70
Unadjusted R^2	[6]	0.941
Adjusted R^2	[7]	0.938

Notes:

* Indicates significance at the 10% level.

** Indicates significance at the 5% level.

*** Indicates significance at the 1% level.

28. How much of the variation of the other 67 (of 70) observations does Dr. Ferrell's model explain? To answer this question, I apply the following procedure:

   a. I replicate Dr. Ferrell's analysis for Estimation Period 2 (August 11, 2015 through December 20, 2020) as shown in Exhibit 3 of the Ferrell Report;

   b. I apply his model to obtain the predicted XRP returns over this period of time; this is the "in-sample" fit of Dr. Ferrell's model;

   c. I omit the three large returns mentioned above and regress the remaining 67 months of XRP returns on their fitted values to determine how much of the variation of those remaining observations is explained by Dr. Ferrell's model.

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[28] Regressing on both the observations on May 16, 2017 and April 18, 2017 results in an unadjusted R^2 of 0.866. The contribution of April 18, 2017 is found as 0.134 = 0.866 - 0.732. *See* Brattle Workpapers.

[29] Regressing on the observations on May 16, 2017, April 18, 2017, and December 26, 2017 results in an unadjusted R^2 of 0.941. The contribution of December 26, 2017 is found as 0.075 = 0.941 - 0.866. *See* Brattle Workpapers.

29. The results are presented in Figure 5. The (unadjusted) R^2 is 0.328, meaning that while Dr. Ferrell's model explains 93.5% of the variation of all 70 months, at best it only explains 32.8% of the variation of 67 of those 70 months.[30]

FIGURE 5: DR. FERRELL'S MODEL EXPLAINS NO MORE THAN 32.8% OF THE VARIATION FOR 67 OF 70 MONTHS IN ESTIMATION PERIOD 2

		Coefficient [A]
Constant	[1]	0.00
Fitted XRP Returns	[2]	0.48***
Observations	[3]	67
Unadjusted R^2	[4]	0.328
Adjusted R^2	[5]	0.318

Notes:

* Indicates significance at the 10% level.

** Indicates significance at the 5% level.

*** Indicates significance at the 1% level.

30. From Figure 5 we see that Dr. Ferrell's model is statistically unbiased—alpha is numerically close to zero and one cannot reject the hypothesis that it is zero at any reasonable significance level. However, his model over-predicts (both positively and negatively) actual returns by a factor of about two (the coefficient on the fitted values, its "beta," is 0.48 in Figure 5). In other words, if Dr. Ferrell's model predicts an XRP return of +10%, the best guess of what the *actual* XRP return is to cut that in half to about 4.8%.

## C.   Dr. Ferrell Does Not Discuss the Economically Significant Returns Not Explained by His Models

31. As noted above, Dr. Ferrell purports to find that "XRP price returns are unrelated to factors over which Ripple may have control." This sweeping conclusion is based exclusively on the overall ***average*** co-

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30   I say "at best" because this calculation of 32.8% is predicated on our being allowed to optimally adjust the predictions of his model to best match the data. In fact, if we take those model predictions as given without adjustment, the conventional R^2 calculation is not well defined (it is actually negative) since the variance of the errors of Dr. Ferrell's model is actually greater than the variance of the data itself in these 67 months. Taking Dr. Ferrell's model predictions as given, the implied unadjusted R^2 from his model over those 67 months is -0.0523. This negative R^2 results because the variance of the *errors* from Dr. Ferrell's model is actually greater than the variance of the XRP return data itself.

movements between XRP and the cryptocurrency market that he finds by way of regression analysis. Setting aside the fact that just three extreme XRP returns give Dr. Ferrell's model the appearance of a good fit, Dr. Ferrell does not perform any assessment of news or other company specific information that could be driving XRP prices on an intraday, daily, weekly, or even monthly basis.

32. In Figure 6 and Figure 7, I present the 28-day excess net returns for XRP in Dr. Ferrell's model for Estimation Periods 1 and 2, respectively. Each bar on the chart represents the difference between the predicted XRP return from Dr. Ferrell's model and the actual XRP price return (net of the risk-free rate). The differences are often substantial, with XRP deviating from Dr. Ferrell's model by more than 50% in many months and sometimes by well over 100%.

FIGURE 6: XRP 28-DAY NET RETURN UNEXPLAINED BY DR. FERRELL'S MODEL (ESTIMATION PERIOD 1)
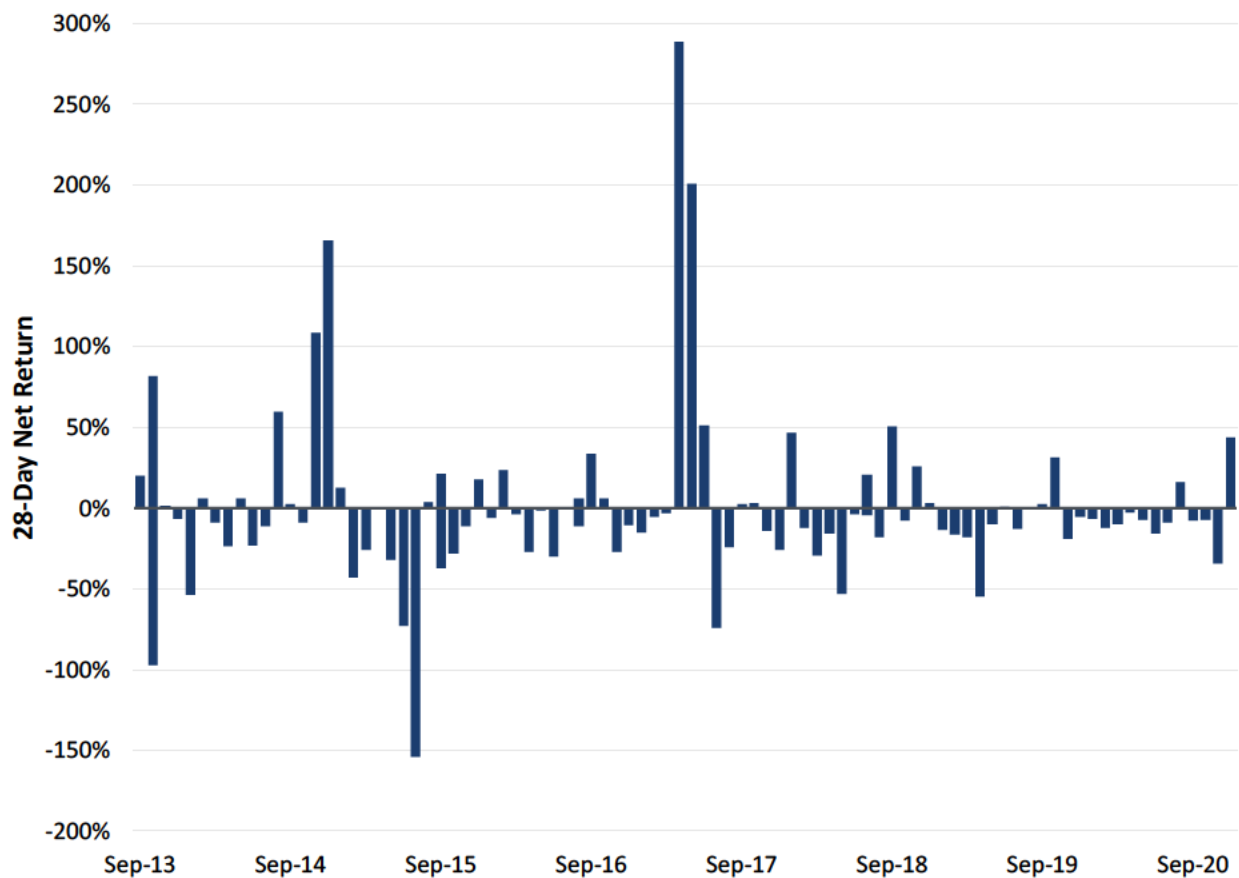

Source: Brattle Workpapers.

FIGURE 7: XRP 28-DAY NET RETURN UNEXPLAINED BY DR. FERRELL'S MODEL (ESTIMATION PERIOD 2)
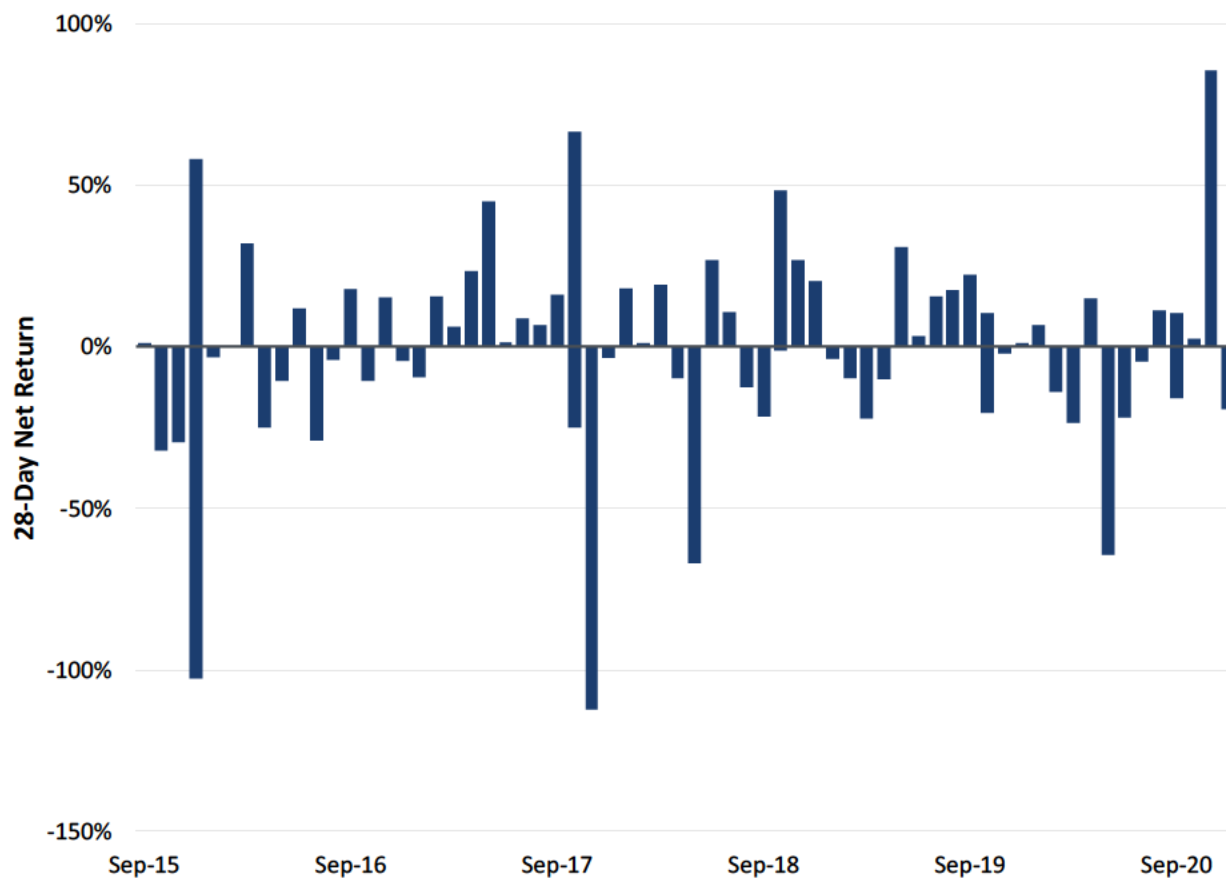
Source: Brattle Workpapers.

33. It should be apparent from both of these figures that economically significant deviations from Dr. Ferrell's model occur in almost every 28-day return period. Therefore Dr. Ferrell's claim that "XRP price returns are unrelated to factors over which Ripple may have control" is unsupported. He did not perform any testing to see whether Ripple news or actions coincided with any of these unexplained returns.

34. To further illustrate the difference between Dr. Ferrell's models and the data, in Figure 8 and Figure 9, I plot XRP prices predicted by Dr. Ferrell's Exhibit 3 factor models versus XRP's actual prices. As shown, both his Period 1 factor model and his Period 2 factor model predict biased XRP prices.

FIGURE 8: FERRELL EXHIBIT 3 PREDICTED VS. ACTUAL XRP PRICES FOR ESTIMATION PERIOD 1
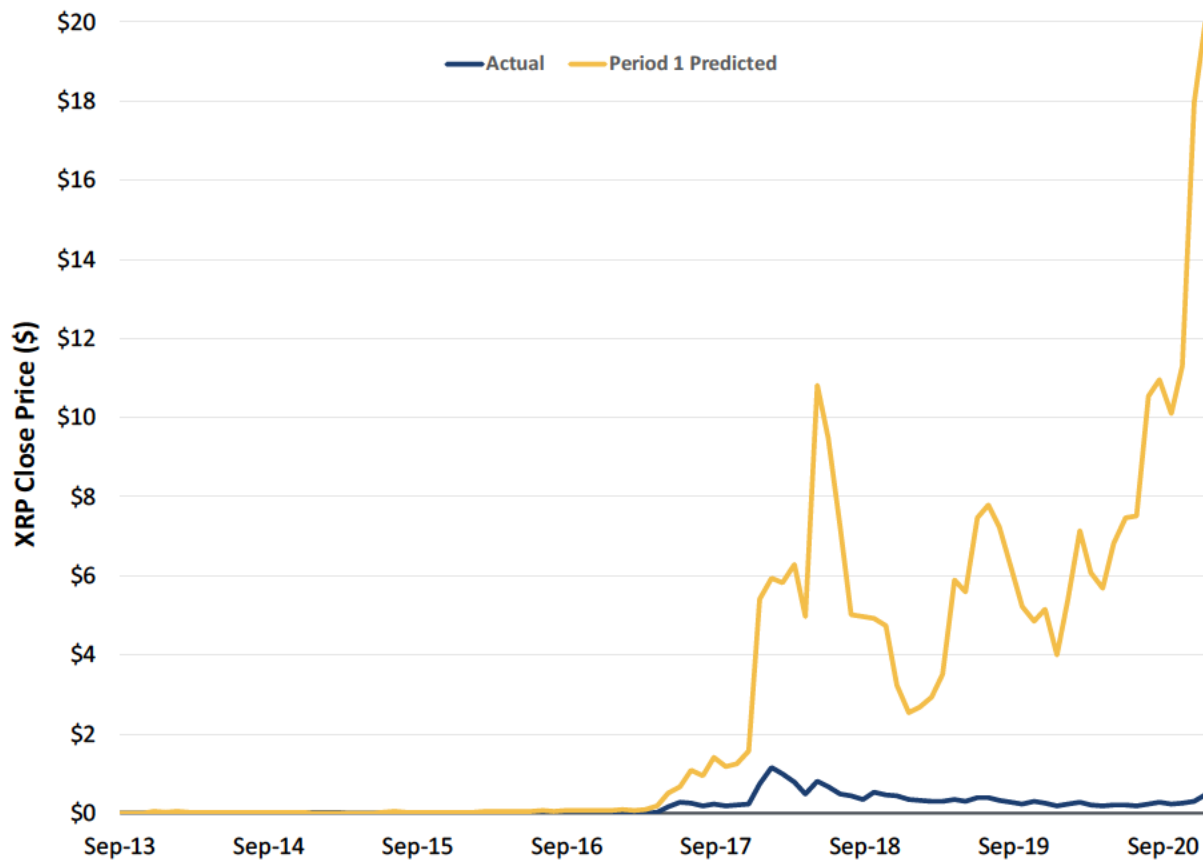
Source: Ferrell Report Backup Files.

Note: Predicted prices are based on XRP's price on August 6, 2013, as the starting point, compounded with monthly returns predicted from Dr. Ferrell's model (with the risk-free rate added back).
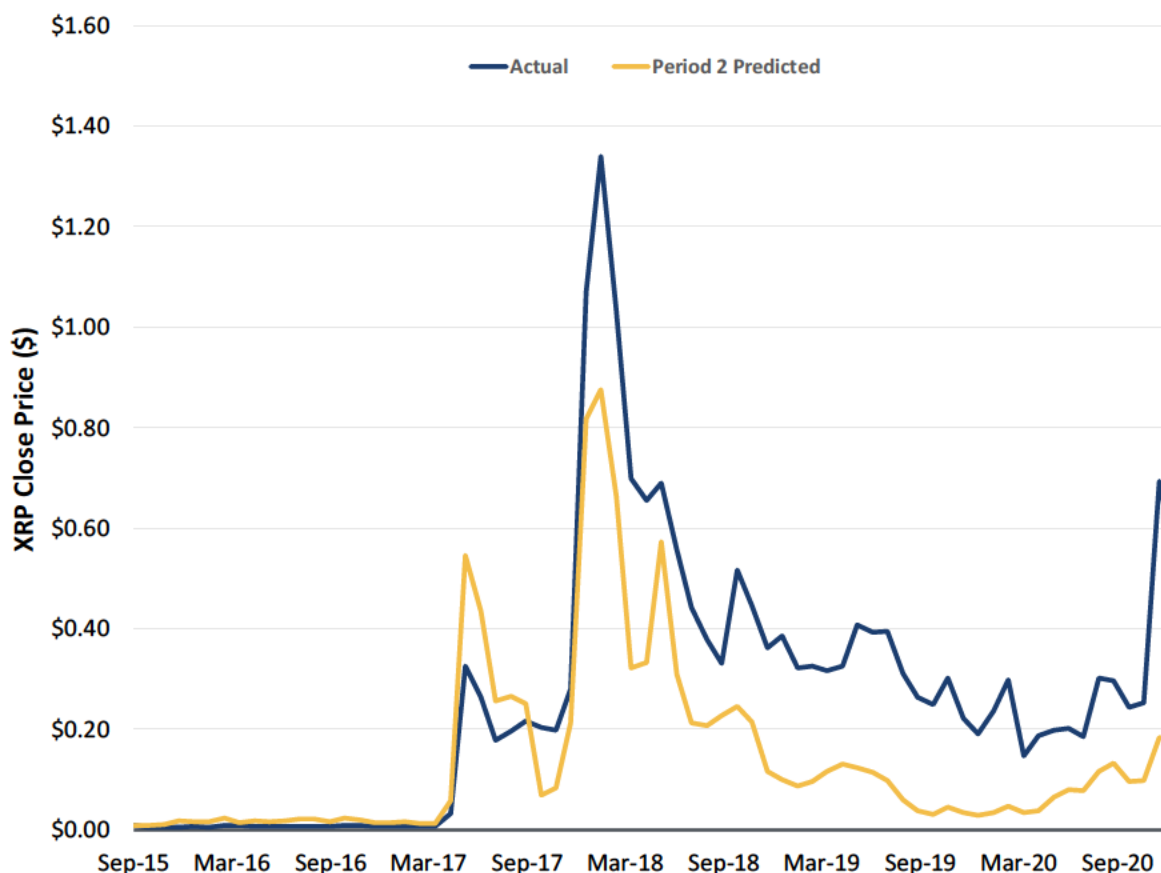
FIGURE 9: FERRELL EXHIBIT 3 PREDICTED VS. ACTUAL XRP PRICES FOR ESTIMATION PERIOD 2

Source: Ferrell Report Backup Files.

Note: Predicted prices are based on XRP's price on August 11, 2015, as the starting point, compounded with monthly returns predicted from Dr. Ferrell's model (with the risk-free rate added back).

VI. Dr. Ferrell's Analysis Is Not Robust

35. In Section V I explained that Dr. Ferrell's statistical framework does not "test" anything meaningful to the matter at hand. In this section I will show that it is also not robust and is prone to numerical instability.

36. In what follows I focus on the various analyses of Dr. Ferrell which make use of principal components. The Ferrell Report does include analysis based on digital token returns directly and not on principal components constructed therefrom. Dr. Ferrell claims, for example, that his regressions summarized in Exhibit 5 "demonstrates that the importance of the underlying cryptocurrencies in explaining variation

in XRP price return hold even if I make no use of the PCA."[31] While it is true that these regressions do not make use of the PCA, it must be pointed out that they still do not address whether actions by Ripple impact XRP prices. The ▮▮▮ Report already included regression models with control for the returns of other digital tokens yet nevertheless found statistically significant evidence that XRP prices were associated with certain news and actions of Ripple.[32]

A.   Dr. Ferrell Appears Not To Have Conducted Basic Due Diligence on His Data Sources

37.   Dr. Ferrell appears not to have reviewed his data for outlier (and invalid) observations. Outliers (observations that are unusually large or unusually small) can be legitimate—*e.g.*, a digital token can have very large price swings in certain periods—or they can indicate errors in the underlying data. In either case outliers can have important effects on the results.

38.   As just one example, the price data used by Dr. Ferrell includes what are surely incorrect values for the digital token, THC. Dr. Ferrell combines two sources of price data to form his final data on digital token prices—CryptoCompare and CoinMarketCap. From January 14, 2016 to December 20, 2020, Dr. Ferrell uses THC prices from CryptoCompare, whereas he uses prices from CoinMarketCap for dates prior to January 14, 2016.[33] As shown in Figure 10, most prices for THC are fractions of a cent, but there are three dates (August 21, 22, and 23, 2017) when THC prices are reported to reach values of over ten million U.S. dollars per token in the CryptoCompare data.

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[31]   Ferrell Report, ¶ 99

[32]   Furthermore, the ▮▮▮ Report presented evidence that the relationship between XRP returns and the returns of other digital tokens, at least at the daily frequency, was not stable over time. Dr. Ferrell's regression models do not allow for any variation in parameters over periods of between five and seven years.

[33]   Ferrell Report Backup Files.

FIGURE 10: DAILY THC MARKET PRICES (DR. FERRELL'S MERGED DATA)
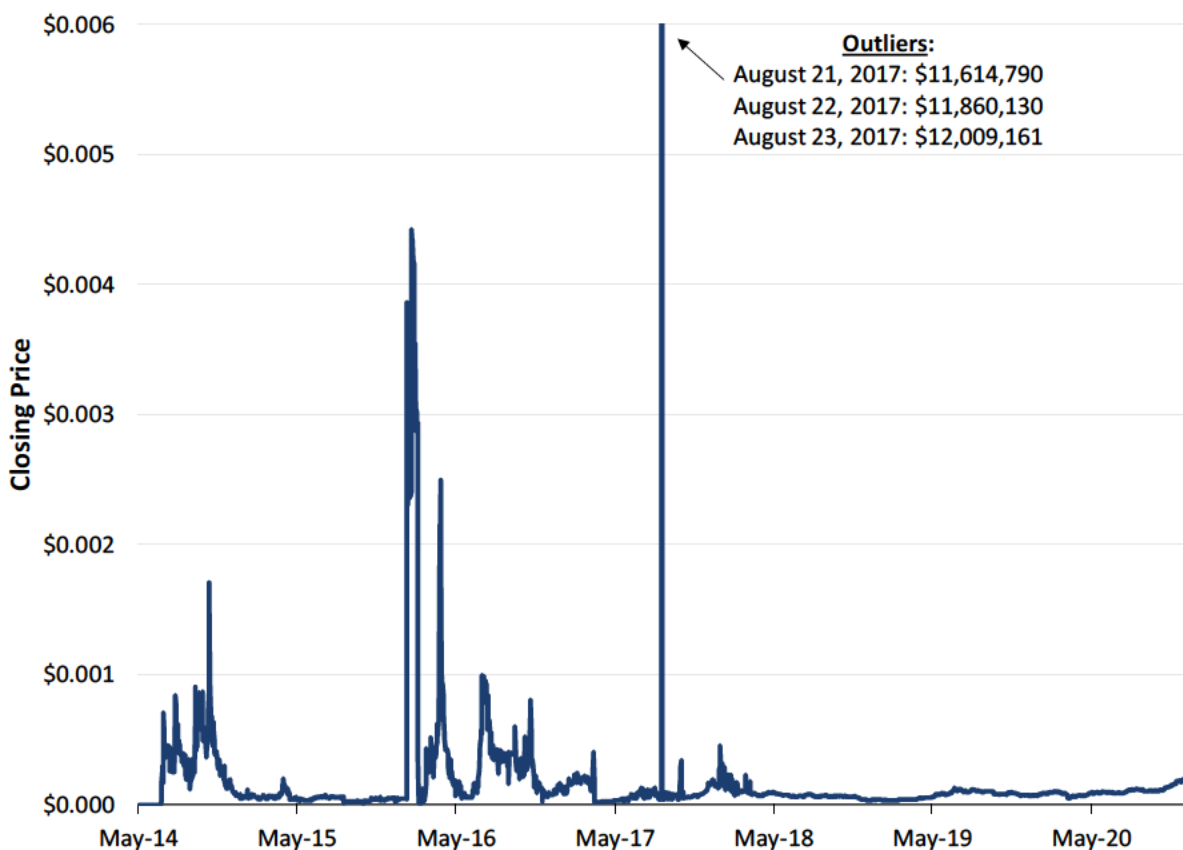
Source: Ferrell Report Backup Files.

Note: Closing prices as constructed by Dr. Ferrell.

39. The prices for these three dates seem clearly inaccurate, as the all-time high price of THC outside of these three dates is never reported to have exceeded a dollar in either of Dr. Ferrell's pricing data sources. I can further confirm the inaccuracy of these prices when comparing the Cryptocurrency prices on these dates to the CoinMarketCap prices. As shown in Figure 11, THC prices from CoinMarketCap from August 21 to 23, 2017, do not even reach two cents and do not appear unusual compared to the prices immediately before and after. The outlier prices (which appear to be whole numbers) found on the three days cannot be reconciled.

FIGURE 11: DAILY THC CLOSING PRICES (IN USD)

| Dates	CryptoCompare Price	CoinMarketCap Price	Ferrell Report Price
8/17/2017	$ 0.000043	$ 0.006826	$ 0.000043
8/18/2017	$ 0.000041	$ 0.006744	$ 0.000041
8/19/2017	$ 0.000083	$ 0.007288	$ 0.000083
8/20/2017	$ 0.000041	$ 0.007412	$ 0.000041
8/21/2017	$ 11,614,790.000000	$ 0.009061	$ 11,614,790.000000
8/22/2017	$ 11,860,130.000000	$ 0.010072	$ 11,860,130.000000
8/23/2017	$ 12,009,161.000000	$ 0.014453	$ 12,009,161.000000
8/24/2017	$ 0.000043	$ 0.012877	$ 0.000043
8/25/2017	$ 0.000087	$ 0.012270	$ 0.000087
8/26/2017	$ 0.000087	$ 0.011080	$ 0.000087
8/27/2017	$ 0.000043	$ 0.010391	$ 0.000043

Source: Ferrell Report Backup Files.

Note: Ferrell Report Price reflects closing price as constructed by Dr. Ferrell in his model.

40. Dr. Ferrell's apparent failure to conduct basic due diligence has further consequences for his Period 2 analysis because THC is one of the coins used to construct the principal components for Period 2 (the principal components for Period 1 do not incorporate THC). To be specific, for THC prices, Dr. Ferrell switches from CoinMarketCap data to CryptoCompare data on January 14, 2016. As a result, there is an apparent jump in THC prices on January 14, 2016 due to the price differences *across* the two sources, not because of real changes in the market. The 28 day return calculated by Dr. Ferrell thus conflates whether prices changed over those 28 days with the fact that the price data sources change.

41. This is shown in Figure 12. Dr. Ferrell's Estimation Period 2 includes the 28 day return from December 29, 2015 to January 26, 2016. There is only one data source available (CoinMarketCap) which reports that 28 day price return for THC, and that data source indicates a gross return of -1%.[34] However, by splicing the two data sources together as Dr. Ferrell does, he calculates an absurd gross return of 8,916%.[35]

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[34] This follows from: -0.01 = 0.000047089 / 0.000047558 − 1.

[35] This follows from: 89.16 = 0.004288 / 0.000047558 − 1.

FIGURE 12: COINMARKETCAP VS. CRYPTOCOMPARE PRICES FOR THC
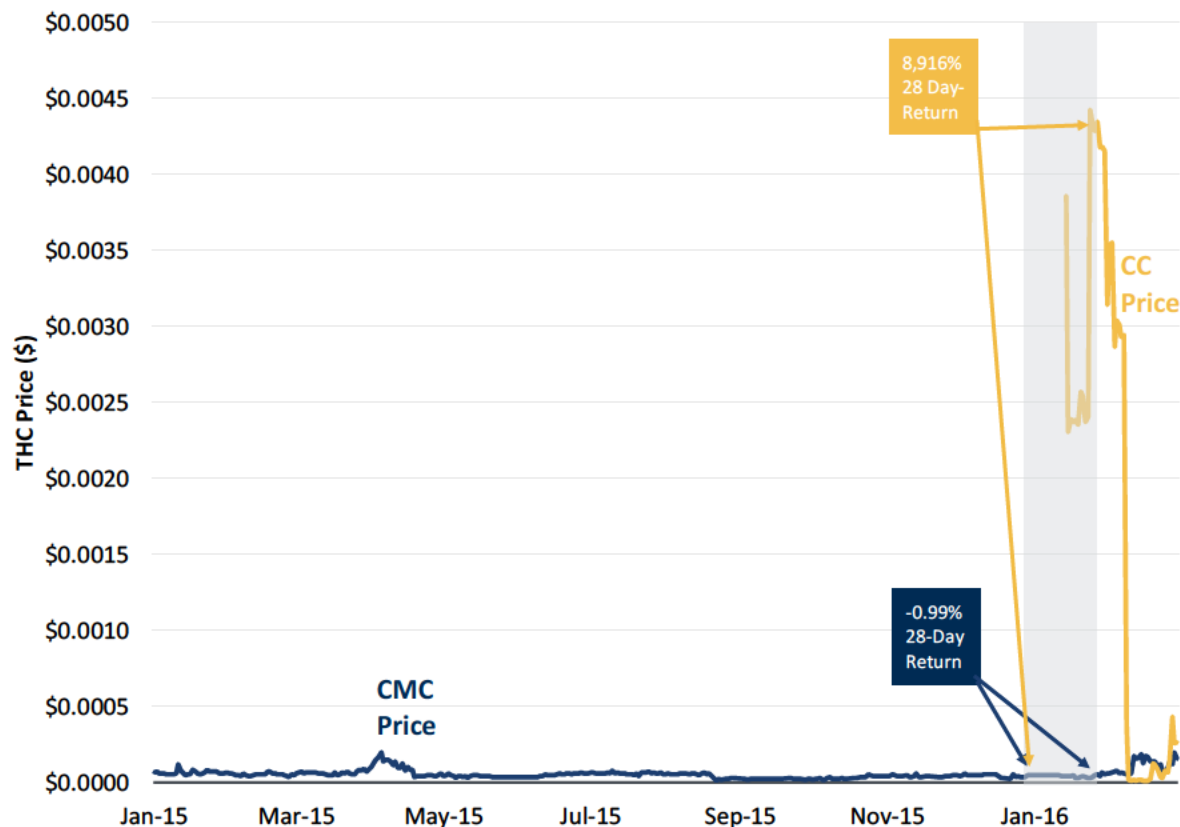
Source: Ferrell Report Backup Files.

42. Because of such a high (artificial) variance of THC returns, THC is given a weight of 0.998 in the second PC used in Period 2, as depicted in Figure 13.[36] This means that the second PC in Dr. Ferrell's analysis is, essentially, just equal to the THC token's returns. It might have struck some researchers as surprising that essentially the entire second PC across 91 digital tokens was comprised of a single token, the THC token, one of the so-called "cannabis coins."[37] Further investigation might have led a researcher to question the merit of splicing the two pricing data sources together in the manner Dr. Ferrell adopts, since that methodology is responsible for the artificial variance in question.

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[36] Recall that principal components are ordered by the amount of variation they explain in the reference data. The first principal component is the most effective at explaining the variance, the second principal component is the next most effective, and so on. For Period 2 Dr. Ferrell constructs 69 principal components.

[37] *See*, e.g., "Cannabis Coins" at https://cryptoslate.com/cryptos/cannabis/, accessed November 11, 2021.

FIGURE 13: TOP 10 COINS BY WEIGHT (ABSOLUTE VALUE) FOR THE SECOND PRINCIPAL COMPONENT (ESTIMATION PERIOD 2)

Coin	Weight
THC	0.9983
EMC	0.0217
XEM	0.0191
ETH	0.0160
MAX	0.0159
XBC	0.0127
42	0.0120
BLOCK	0.0113
ANC	0.0113
BTB	0.0109

Source: Ferrell Report Backup Files.

43. The first two PCs as constructed by Dr. Ferrell in his Estimation Period 2 collectively account for 96.6% of the variation in his data set.[38] However, if I regress XRP returns on those first two PCs, I find that they have no explanatory power for XRP at all—the adjusted R^2 is actually negative (see Figure 14). On the other hand, if the THC token is dropped from the analysis of Estimation Period 2, a very different second PC results, one which is more correlated with XRP returns. Now if I regress XRP returns on the first two PCs, I find that they explain almost 30% of XRP returns (see Figure 14).

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[38]   Ferrell Report, Exhibit 2.

FIGURE 14: REGRESSION RESULTS OF XRP RETURNS ON PC1 AND PC2 (WITH AND WITHOUT DROPPING THC COIN)

		Coefficient (Original) [A]	Coefficient (THC dropped) [B]
Constant	[1]	0.251	0.071
Principal Component 1	[2]	-0.001**	-0.001***
Principal Component 2	[3]	-0.003*	0.129***
Observations	[5]	70	70
Unadjusted R^2	[6]	0.002	0.293
Adjusted R^2	[7]	-0.028	0.272

Notes:

* Indicates significance at the 10% level.

** Indicates significance at the 5% level.

*** Indicates significance at the 1% level.

44. Besides failing to check for outliers in his data, Dr. Ferrell also fails to assess whether his dataset is sufficiently large to perform this analysis. As described in the preceding section, Dr. Ferrell constructs several factor models to explain the returns on XRP's prices. In all of these models he uses monthly return data (strictly, 28-day return data) to estimate his factor models. Doing so leads to a small sample size, 96 observations for Estimation Period 1 and 70 for Estimation Period 2. This is problematic given that his principal component analysis requires the estimation of a very large number of parameters—for Estimation Period 1 he has to calculate 45 distinct components of a variance-covariance matrix[39] and for Estimation Period 2, he has to calculate 4,186 components.[40] This combination of a small sample and a large number of parameters leads to the robustness issues that are detailed below.

45. This problem could have been avoided by using weekly or daily data, since this would have increased his sample size without increasing the number of parameters that needed to be estimated. However, Dr. Ferrell justifies his use of monthly data by citing to papers that either (i) use a much longer sample (Fama and French (2015) use a sample of over 600 months of data, compared to Dr. Ferrell's 96 and 70

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[39] With 9 non-XRP digital tokens, the variance-covariance matrix is a 9 by 9 matrix, which has 45 unique elements. $9 \times (9+1)/2 = 45$.

[40] With 91 non-XRP digital tokens, the variance-covariance matrix is a 91 by 91 matrix, which has 4,186 unique elements. $91 \times (91+1)/2 = 4,186$.

months),[41] or (ii) also consider more frequent sampling in addition to monthly (Liu and Tsyvinski (2021) use data at daily, weekly, and monthly levels, not just the monthly level).[42]

B.   Dr. Ferrell's Analysis Is Highly Dependent on the Day on Which He Begins His Analysis

46. As a consequence of the issues discussed in Section 36, Dr. Ferrell's analysis is numerically unstable. In particular, the explanatory power of his models is highly dependent on the day on which he begins his analysis. As Dr. Ferrell states in his report, he begins all of his 28-day periods on a Tuesday, arguing in footnote 163 of his report that, "I circumvent any concerns that trading on weekends is of lower volume and of a somewhat different nature … I use Tuesday rather than Monday to reduce the number of U.S. holidays." I note that Dr. Ferrell offers no suggestion that using Wednesday, Thursday, or Friday would be any less valid than Tuesday.

47. For Estimation Period 1, the first 28-day return is September 3, 2013, and the last is December 15, 2020, while for Estimation Period 2 the first is September 8, 2015, and the last would naturally be December 22, 2020, though Dr. Ferrell instead stops the analysis on Sunday, December 20, 2020, apparently in violation of his own concerns. These two estimation periods, in other words, are offset by one week. In the case of Estimation Period 2, Dr. Ferrell arguably cannot begin a week earlier on September 1 because he lacks trading data on Ethereum, a major digital token. However, he certainly could begin Estimation Period 1 one week later on September 10, 2013, if he so chose.

48. What would happen if we replicated Dr. Ferrell's methodology but began on September 10, 2013 instead? Instead of reporting an adjusted R^2 of 54.1% as shown in Exhibit 3 of the Ferrell Report we would have an adjusted R^2 of just 25% (See Figure 15). Thus when Dr. Ferrell writes that "[t]he adjusted R-squared in Estimation Period 1…exceeds 50%," that finding depends on his decision to begin the analysis on September 3 rather than September 10 which would have been consistent with his Estimation Period 2.[43]

49. To determine which is more representative of the power of his first factor model—an R^2 of 54.1% or 25%—Figure 15 plots the adjusted R^2 which results from applying Dr. Ferrell's methodology beginning

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[41]   Eugene F. Fama and Kenneth R. French, "Dissecting anomalies with a Five-Factor Model," *The Review of Financial Studies*, Vol. 29 (1), 2015, pp. 69-103.

[42]   Yukun Liu and Aleh Tsyvinski, "Risks and Returns of Cryptocurrency," *The Review of Financial Studies*, Vol. 34 (6), 2021, pp. 2689-2727.

[43]   Ferrell Report, ¶ 98.

on every Tuesday, Wednesday, Thursday, or Friday in the month of September, 2013. The adjusted R^2 ranges from a low of 13.9% to a high of 57.5% depending on the starting day.

FIGURE 15: ADJUSTED R^2 FOR ALTERNATIVE START DATES FOR ESTIMATION PERIOD 1

50. The analysis of Estimation Period 2 is even more unstable. In this case, Dr. Ferrell is constructing principal components across 91 digital tokens with only 70 observations of each.[44] Even this obscures the fact that many of his tokens do not report pricing data every day over this period of time; if Dr. Ferrell happened to pick a different start date, he would be forced to either drop certain dates (because he does not have data on all 91 tokens on that date) or to drop certain tokens (because they do not have observations on all dates).

51. In Exhibit 2 of Dr. Ferrell's report he notes that the first principal component of Estimation Period 2 accounts for 91.1% of the variation across all 91 tokens in this period. This means that there is a way to combine the returns of these 91 tokens so that 91.1% of the total variation of those returns can be explained by a single time series.

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[44]   In technical terms, the covariance matrix is of less than full rank.

52. In what follows, I apply Dr. Ferrell's methodology starting from different dates in September 2015. I drop any digital token that has missing data in that sequence of 28 days. For example, if I begin on Wednesday September 9, 2015, instead of Tuesday September 8, the tokens MANNA, RBT, and THC are missing some returns in the subsequent sequence of 28 days and hence I drop them from the analysis.

53. For each start date I perform a principal components analysis on the digital tokens with complete data and record the percentage of variation explained by the first principal component. The results are presented in Figure 16. The contribution of the first principal component ranges from a low of 40.3% to a high of 100%. As an example, if Dr. Ferrell had started his analysis just one day later on Wednesday September 9, the first principal component would only have explained 63.5%, not 91.1%, of total variation. In fact, starting on that date, it would take 6 principal components to explain 91% of total variation.[45]

FIGURE 16: VARIATION EXPLAINED BY PRINCIPAL COMPONENT 1 (ESTIMATION PERIOD 2)

54. Looking at September 23, what can it mean that 100% of the variation of about 90 digital tokens can be explained by a single time series? If "true" it would mean that the returns for all 90 tokens are perfectly

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[45]   Brattle Workpapers.

correlated with each other. In reality, it means that the data for these 90 tokens is dominated by a single outlier. In this case, the culprit is the same THC coin discussed in Section VI. When starting on this date, the prices of over $10,000,000 per coin create 28 day returns of almost 16,000,000,000,000%.

C.   Dr. Ferrell's Analysis Ignores That Model Parameters Might Change over Time

55.   As I demonstrated in my opening report, and consistent with other literature on digital token returns, conditions in this market can change over time. Dr. Ferrell's analysis, however, implausibly assumes stable parameters over time for periods of between five and seven years. He assumes, for example, that the construction of principal components is stable, and he assumes that the relationship between XRP returns and those principal components is stable. I demonstrate in this section one simple example that shows how key model parameters can vary over time.

56.   I begin with Dr. Ferrell's analysis of Estimation Period 2. Recall that for this model, Dr. Ferrell estimates that alpha is -0.022 with a standard error of about twice that magnitude, 0.041.[46] As I did above in Section VI.B, I apply this methodology beginning in different days in September of 2015, disregarding any digital token with missing data. The only change I make to his analysis is that, instead of requiring the regression intercept alpha to be constant over the subsequent 5 years, I allow it to change once Ripple receives its BitLicense from New York State. This was announced on June 13, 2016.[47] The first 28-day return measured entirely post-BitLicense would therefore be the return of July 11, 2016.

57.   Figure 17 presents the estimated intercept, alpha, and the change to alpha in the post-BitLicense period. Out of 15 possible "start dates" for Estimation Period 2, (i) four would deliver statistically significant evidence that the average XRP return, net of the risk-free rate and principal component factors, was statistically significantly negative and (ii) five would indicate that the change to that average return was statistically significantly positive.[48] One possible interpretation of these results would be that XRP returns were lagging the market until Ripple Labs obtained its BitLicense.

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[46]   Ferrell Report, Exhibit 3.

[47]   "Ripple Receives New York's First BitLicense for an Institutional Use Case of Digital Assets," Ripple Insights, June 13, 2016, accessed November 11, 2021, https://ripple.com/insights/ripple-receives-new-yorks-first-bitlicense-institutional-use-case-digital-assets/.

[48]   Statistical significance at the 5% level.

FIGURE 17: DR. FERRELL'S EXHIBIT 3 PERIOD 2 INTERCEPT CAN BE SIGNIFICANT AND CHANGES OVER TIME

Period 2 Start Date	Alpha	Post-BitLicense Period Change in Alpha	Adjusted R^2
04-Sep-2015	-0.04	0.05	0.943
08-Sep-2015	-0.14	0.13	0.923
09-Sep-2015	-0.12	0.17	0.963
10-Sep-2015	-0.17	0.23*	0.960
11-Sep-2015	-0.21	0.22	0.881
15-Sep-2015	-0.17**	0.19*	0.963
16-Sep-2015	-0.65*	0.77**	0.813
17-Sep-2015	-0.28*	0.34**	0.965
18-Sep-2015	-0.18*	0.21**	0.966
22-Sep-2015	-0.22**	0.22**	0.944
23-Sep-2015	-0.19**	0.17*	0.891
24-Sep-2015	-0.18	0.15	0.865
25-Sep-2015	-0.16*	0.15	0.917
29-Sep-2015	-0.03	0.02	0.901
30-Sep-2015	-0.36**	0.31**	0.741

Notes:

* Indicates significance at the 10% level.

** Indicates significance at the 5% level.

*** Indicates significance at the 1% level.

For the September 23, 2015 start date, I exclude THC returns for the reasons discussed in Section VI.A. If THC returns are included, Alpha is not significant at the 5% level and the Post-BitLicense Period Change in Alpha is not significant at the 5% level. The adjusted R^2 is negative.

APPENDIX A

Additional Documents Relied Upon

		Date
	Expert Reports	
[1]	Expert Report of Allen Ferrell, Ph.D.	October 4, 2021
	Websites	
[2]	https://cryptoslate.com/cryptos/cannabis/	
	Academic Literature	
[3]	Eugene F. Fama and Kenneth R. French, "Dissecting anomalies with a Five-Factor Model," The Review of Financial Studies Vol. 29 (1), 2015, pp. 69-103.	
[4]	Jim Kyung-Soo Liew, Richard Ziyuan Li, Tamás Budavári, and Avinash Sharma, "Cryptocurrency Investing Examined," The Journal of the British Blockchain Association, Vol. 2(2), 2019, pp. 1-12.	